Meteorological Background for the three ATTREX seasons

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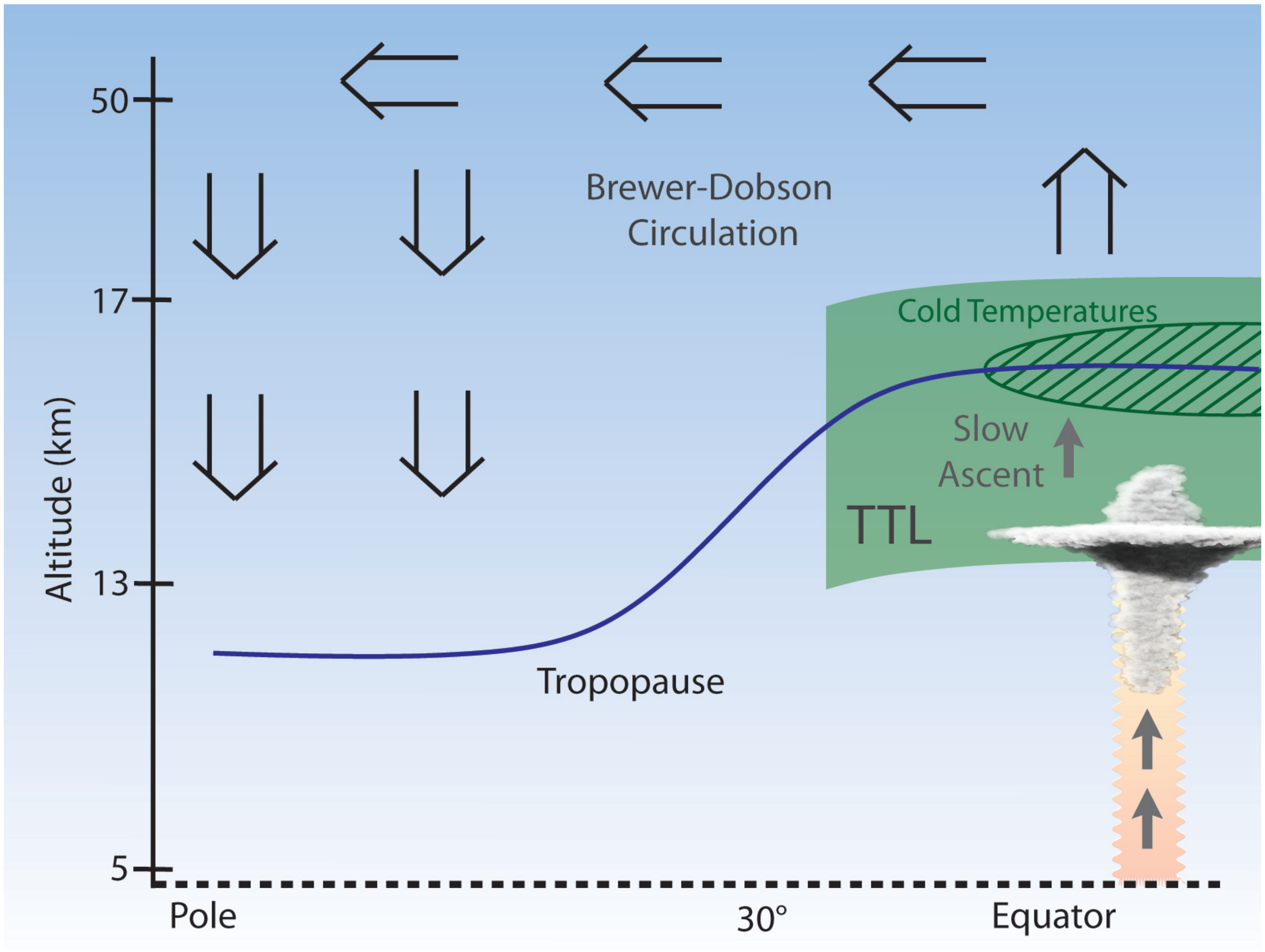
Current schedule calls for 2 Boreal winter campaigns, 1 boreal summer campaign, and 1 early fall test campaign. We will do a met climo discussion in order of the appearance of these campaigns in the schedule. Most of the slides are stolen from Paul's web site.
http://acdb-ext.gsfc.nasa.gov/People/Newman/attrex/attrex.html



50
17
13
5
Altitude (km)
Brewer-Dobson
Circulation
Cold Temperatures
Slow
Ascent
TTL
Tropopause
Pole
30°
Equator

Outline for each period

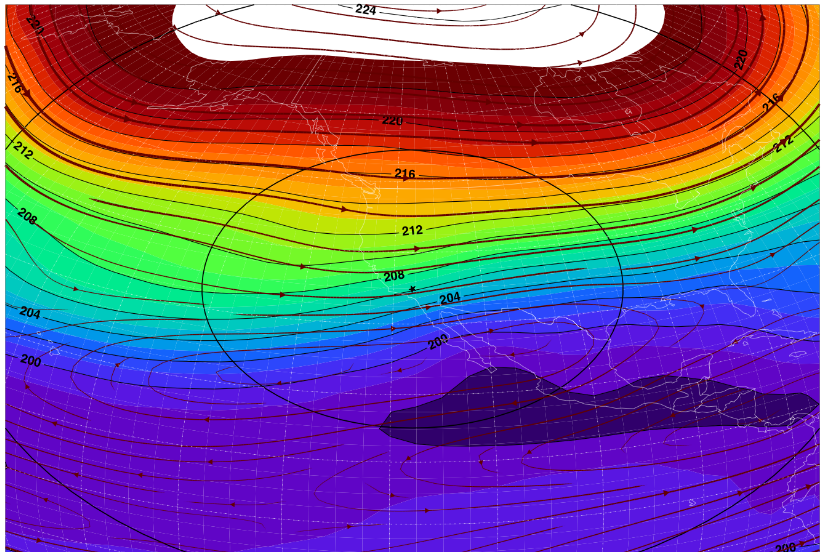
- Mean structure of temperature, water, CO, winds, vertical motion, cirrus clouds, and convection.
- Year to year variations (ENSO – winter and summer)
- Expected variations within the ~1 month campaign window (movies)

Fall season

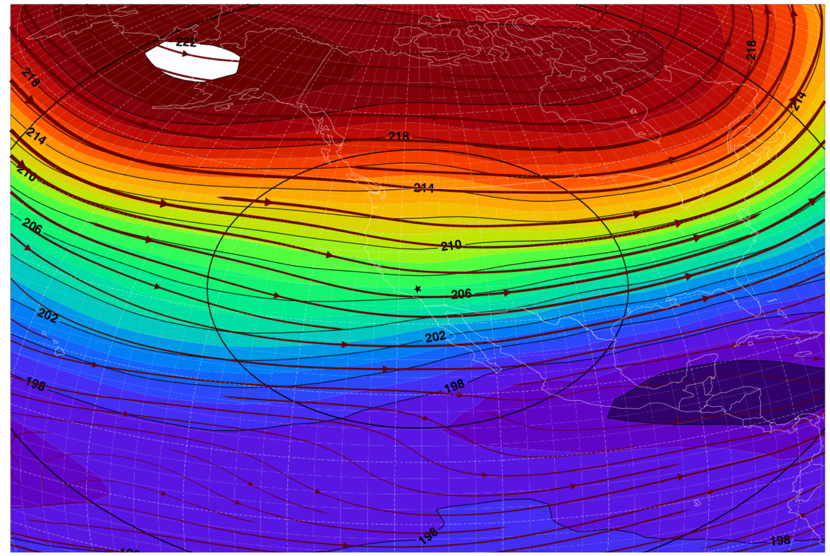
Sept-Nov Dryden test flight phase -- 2011

Fall climatology for Dryden Test Flight Campaign

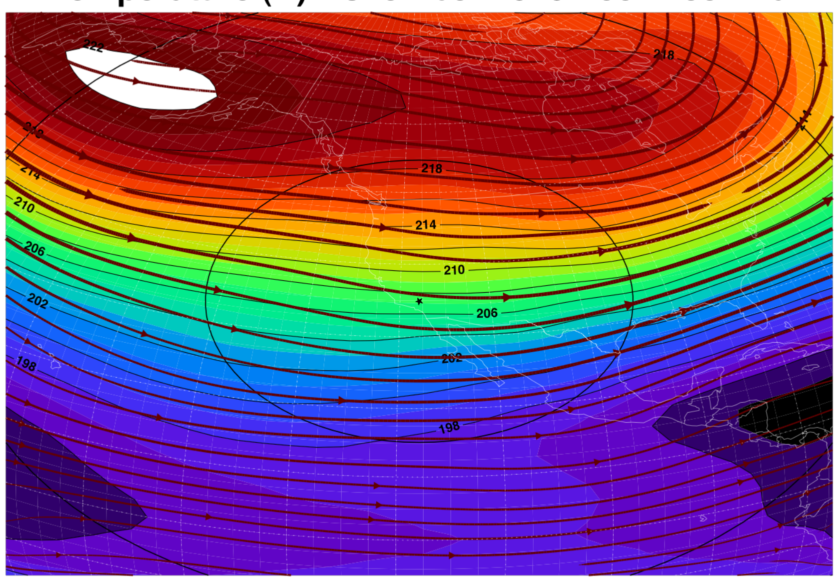
Temperature (K) September 1979-2007 100 hPa



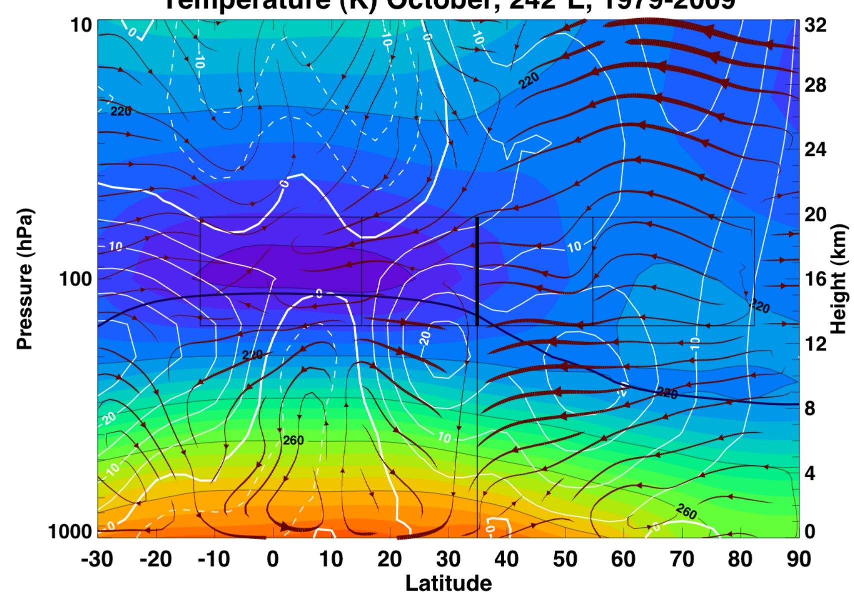
Temperature (K) October 1979-2007 100 hPa



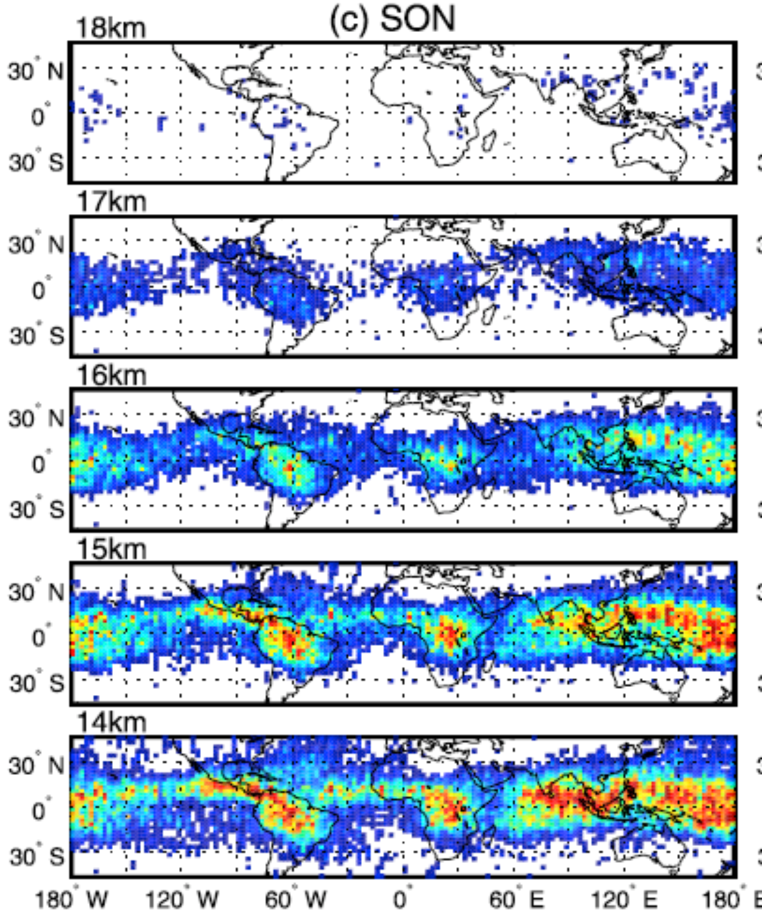
Temperature (K) November 1979-2007 100 hPa



Temperature (K) October, 242°E, 1979-2009

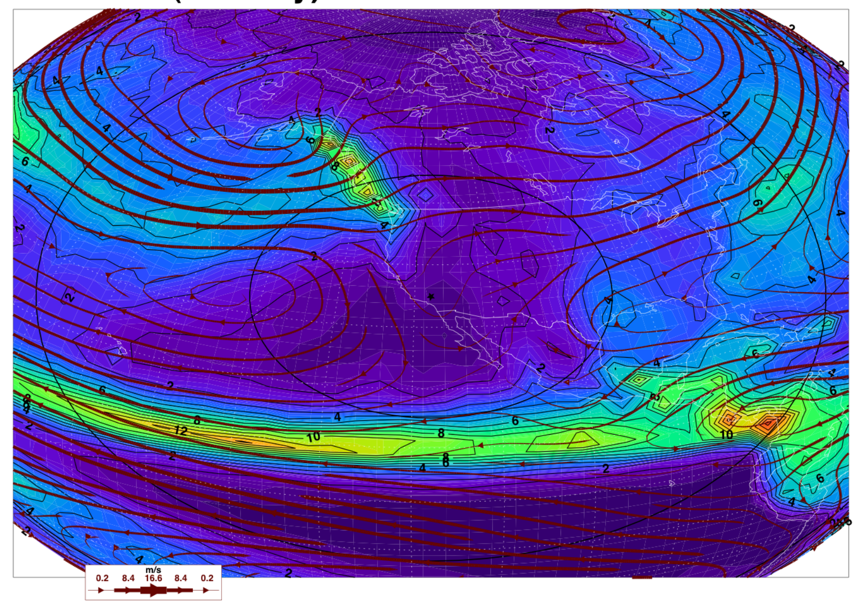


Cirrus cloud fraction, Yang et al 2010

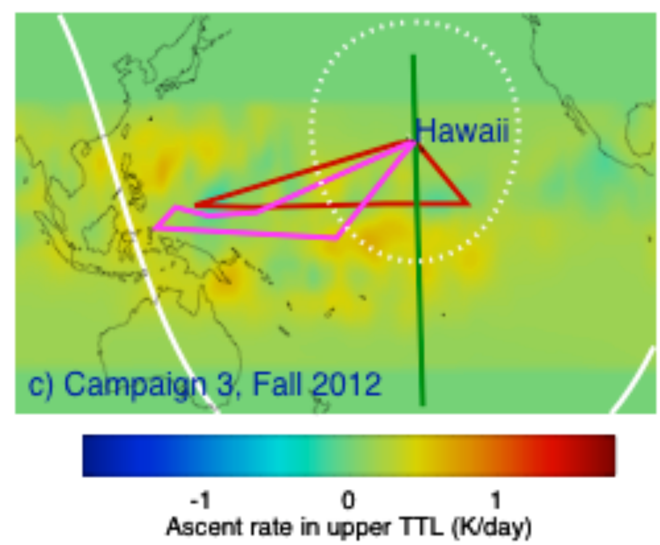


Time of rapid transition in TTL temperature.
ITCZ near 10 degrees.
Cirrus cloud fraction south of DFRC near a global minimum, but dateline region within reach
Upward motion at tropical tropopause south of Dryden is weak, more significant to the west

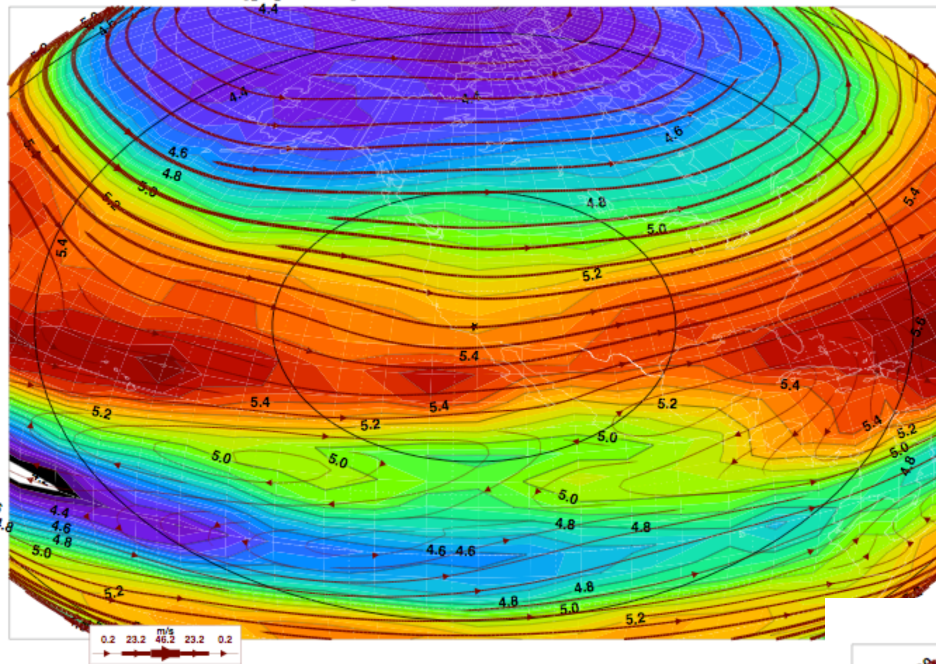
Rain (mm/day) October 1979-2008 850 hPa



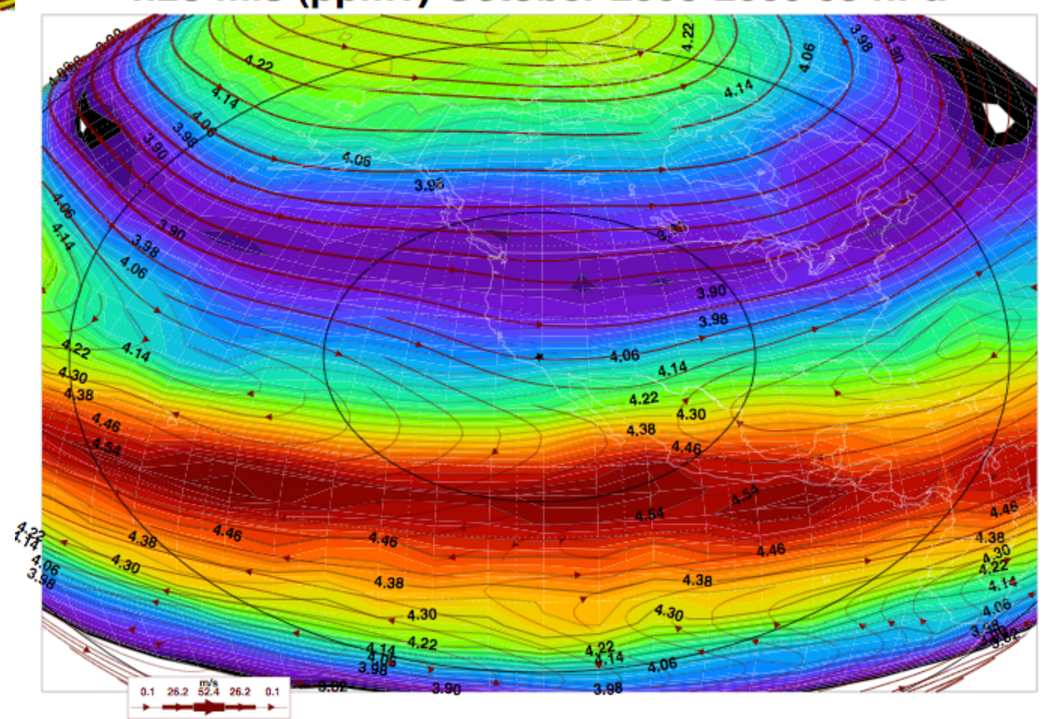
Heating Rates, Yang et al, 2010



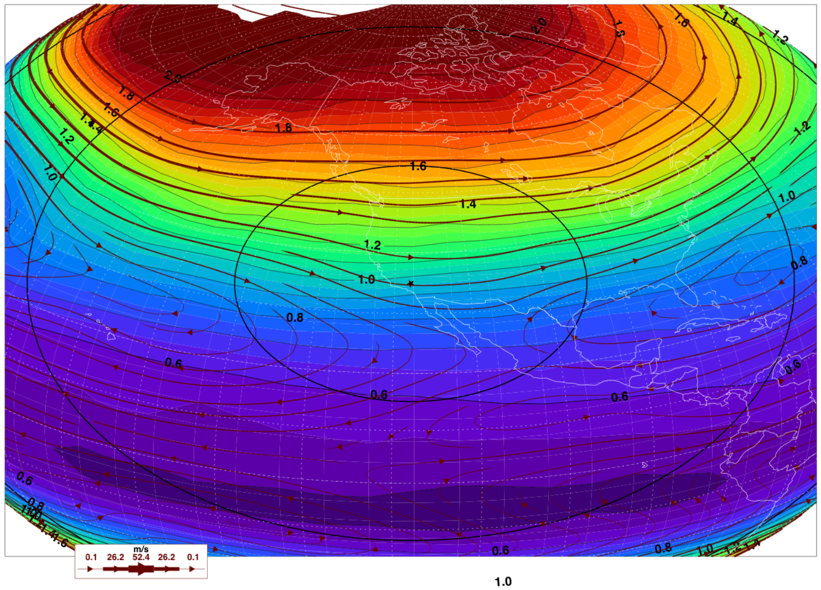
h2o mls (ppmv) October 2005-2009 100 hPa



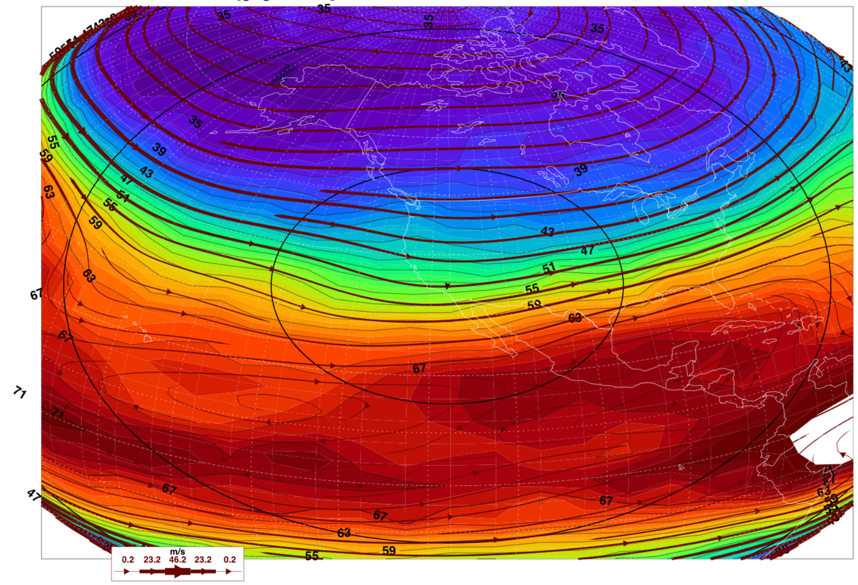
h2o mls (ppmv) October 2005-2009 68 hPa



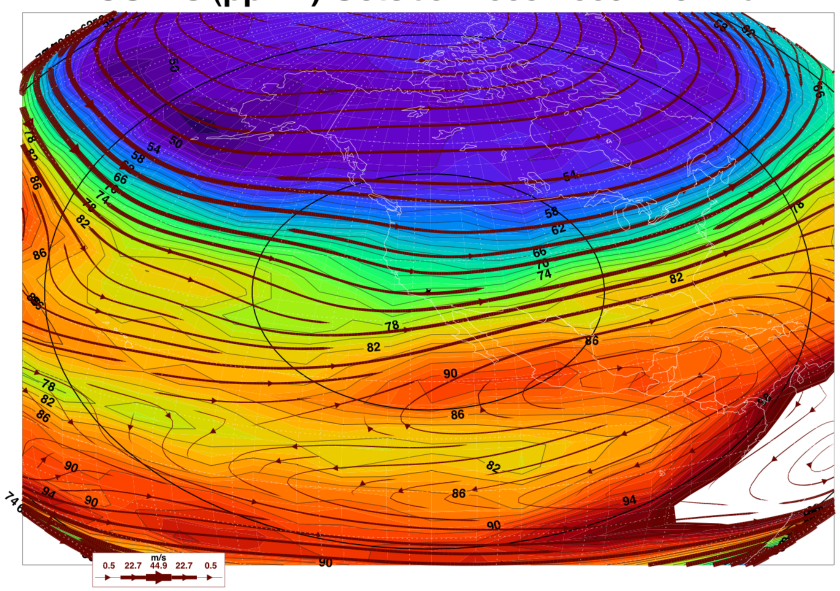
o3mls (ppmv) October 2005-2009 68 hPa



COmls (ppmv) October 2005-2009 100 hPa



COmls (ppmv) October 2005-2009 146 hPa



At lowest GH altitude (left), ITCZ is relatively clean, can see the divergence from ITCZ.

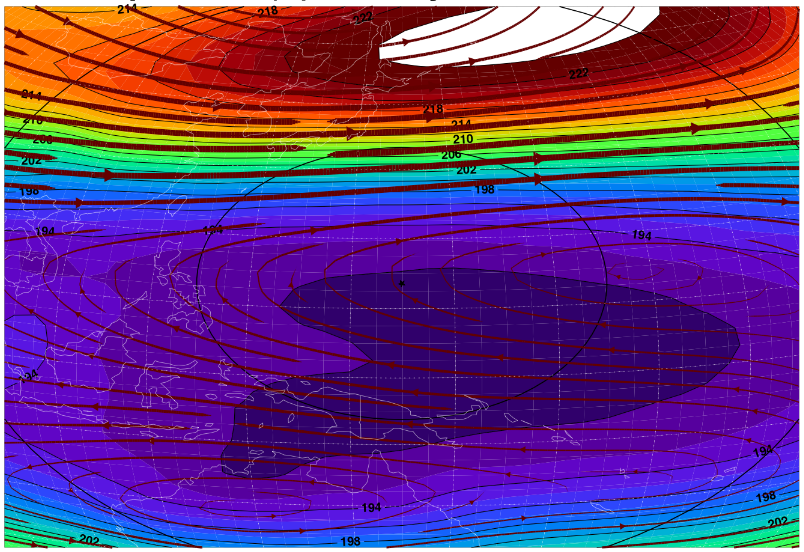
Similar pattern at 100mb – high values SW of HI are south of ITCZ.

Ozone is shown at 70mb. Westerly flow is already established (30 m/s over northwest Pacific), with strong ozone gradients. Not much variation in CO at this altitude (not shown).

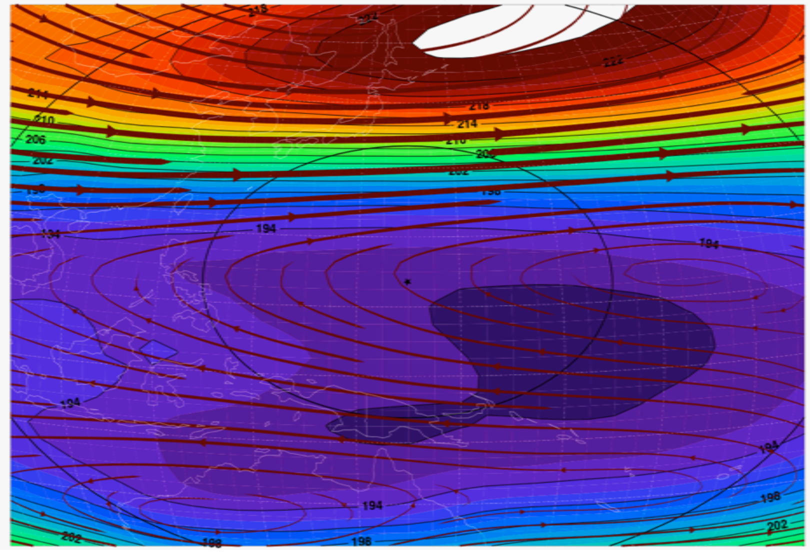
Boreal Winter Season

January-February 2013 and 2014

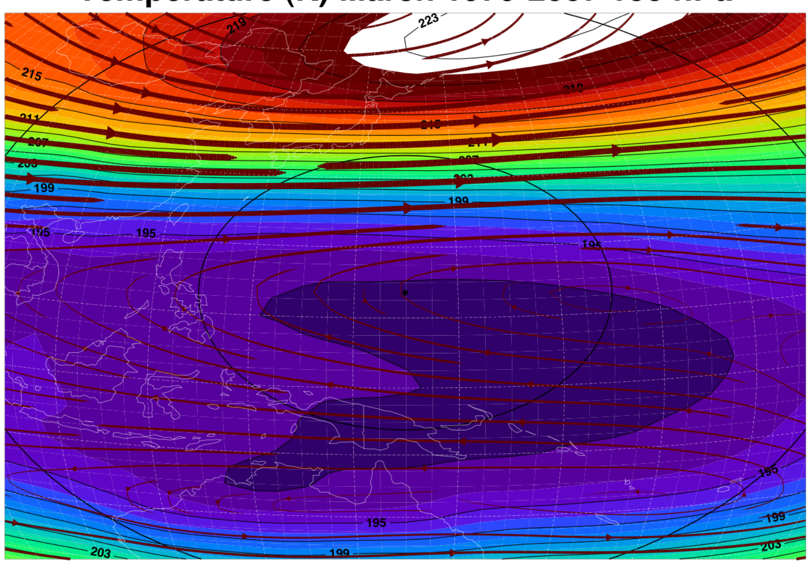
Temperature (K) January 1979-2007 100 hPa



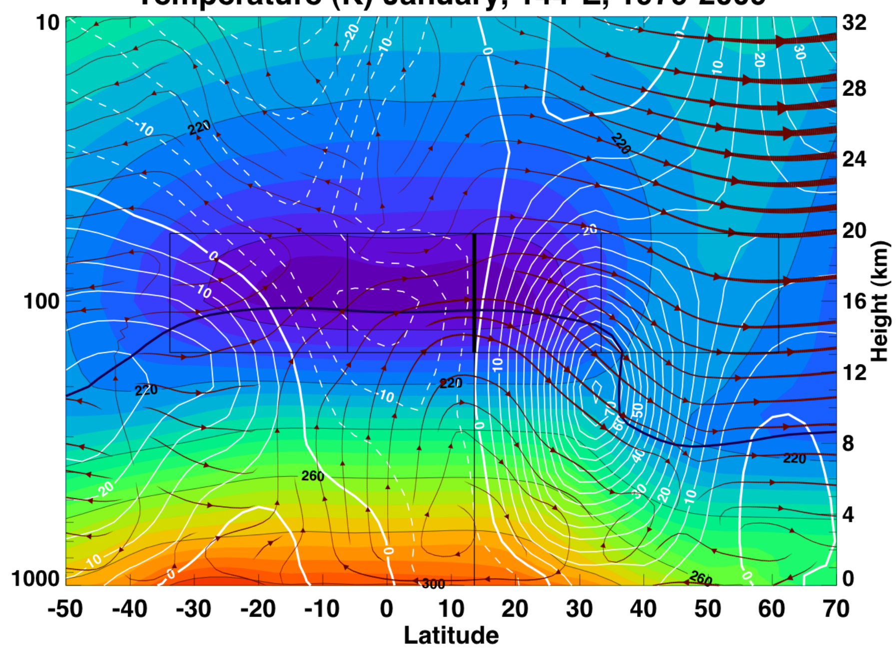
Temperature (K) February 1979-2007 100 hPa



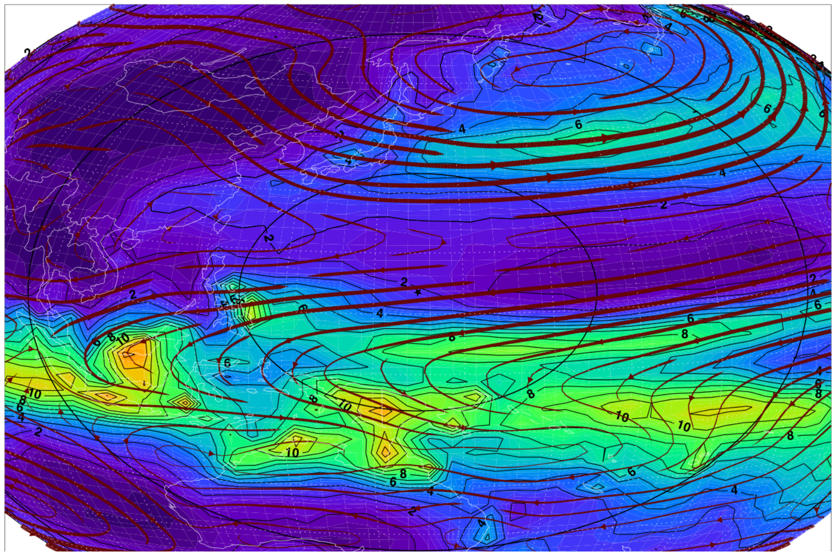
Temperature (K) March 1979-2007 100 hPa



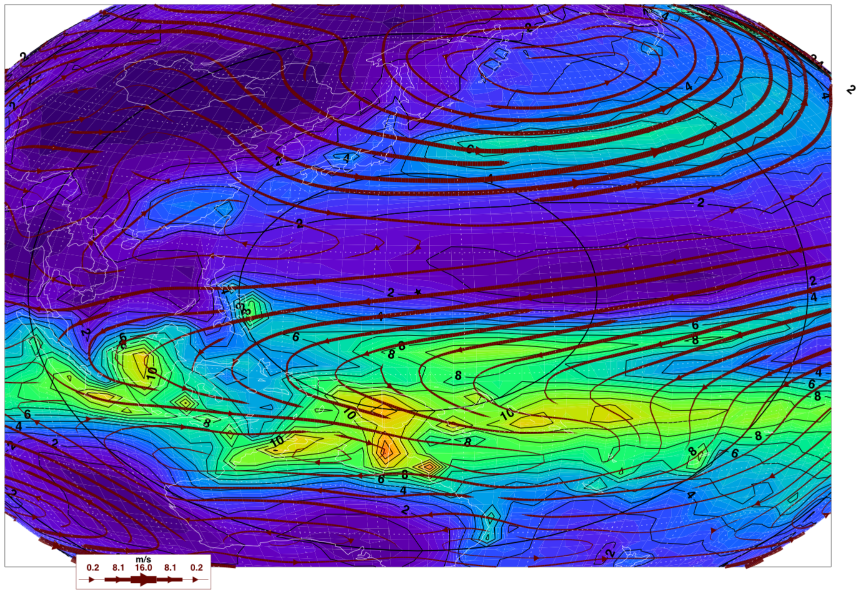
Temperature (K) January, 144°E, 1979-2009



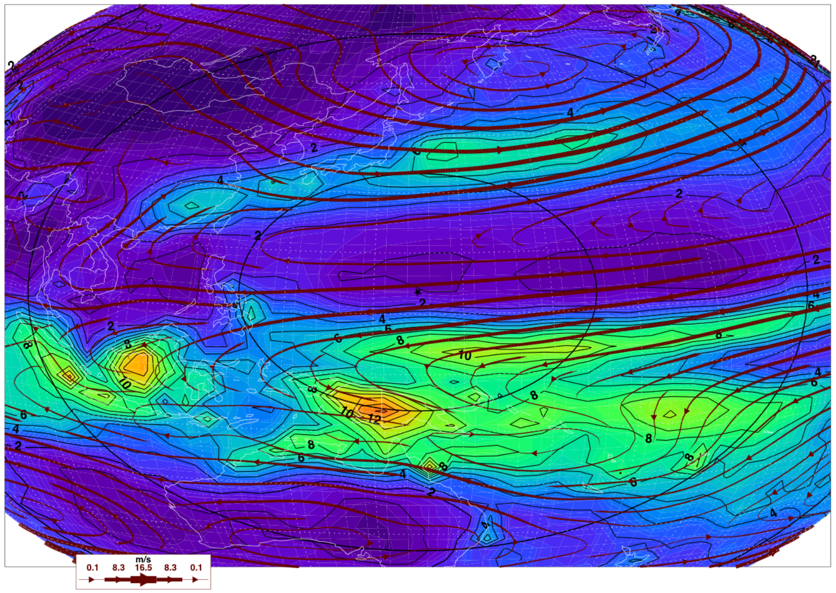
Rain (mm/day) January 1979-2008 850 hPa



Rain (mm/day) February 1979-2008 850 hPa



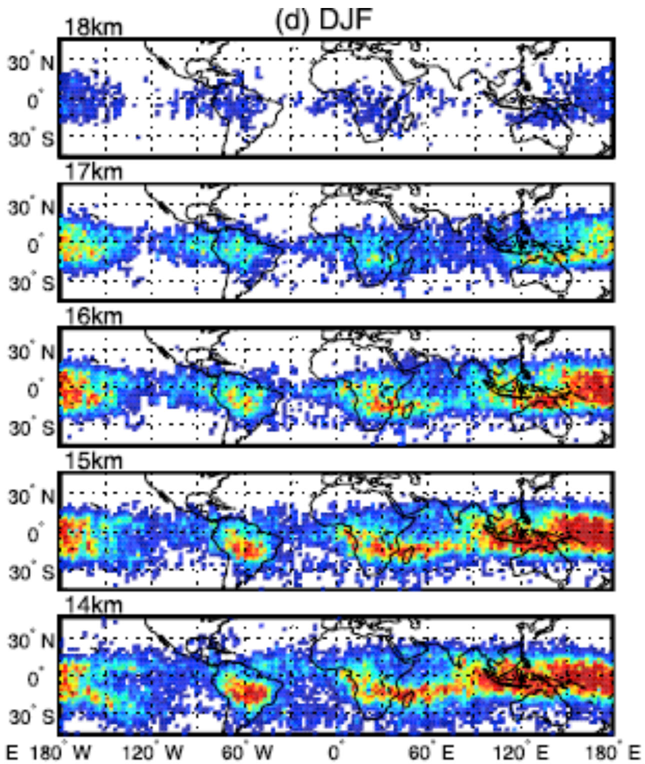
Rain (mm/day) March 1979-2008 850 hPa

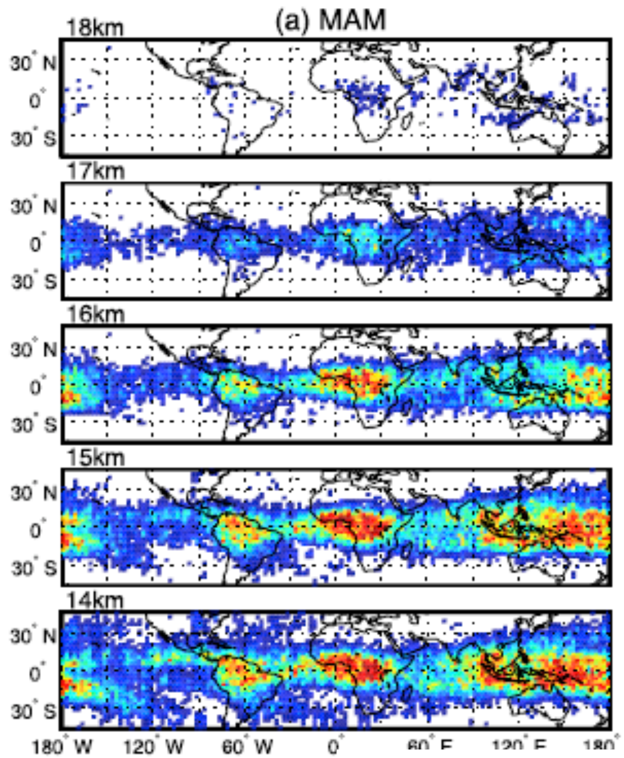


January and February are quite similar in rain rate and TTL temperature structure.

March rainfall somewhat less, especially in the SPCZ and Australian monsoon.

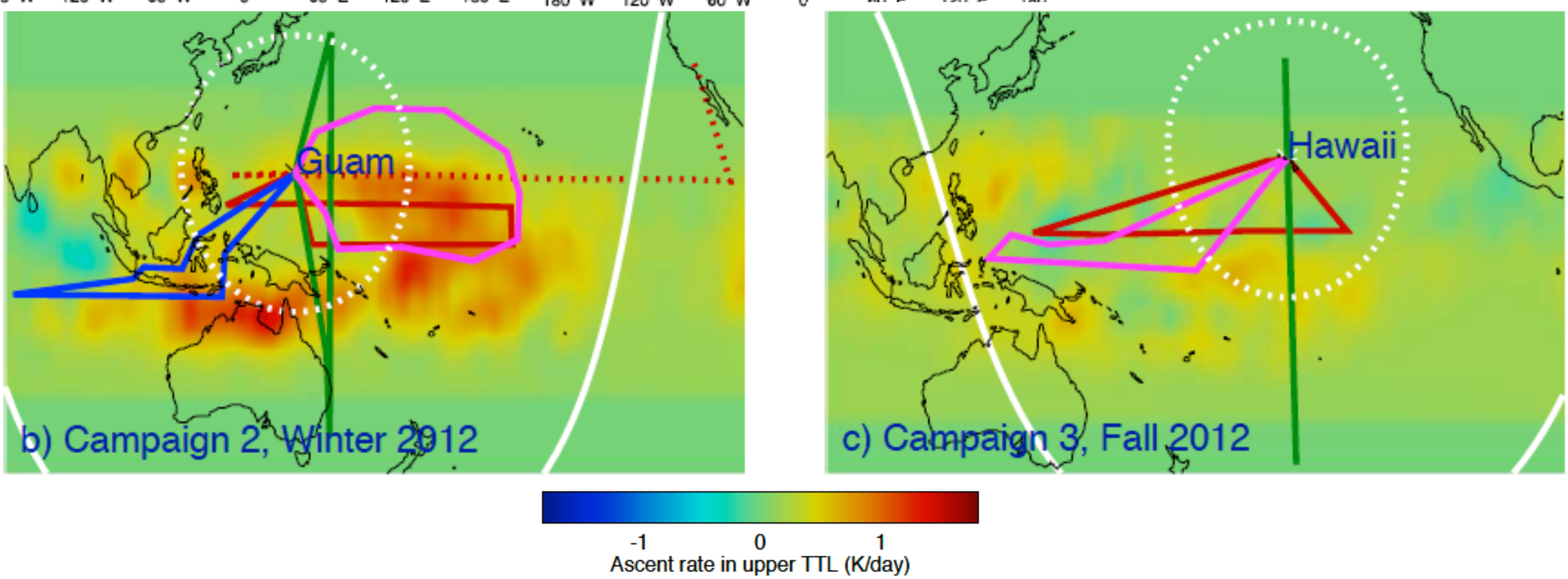
March is the driest at Guam.



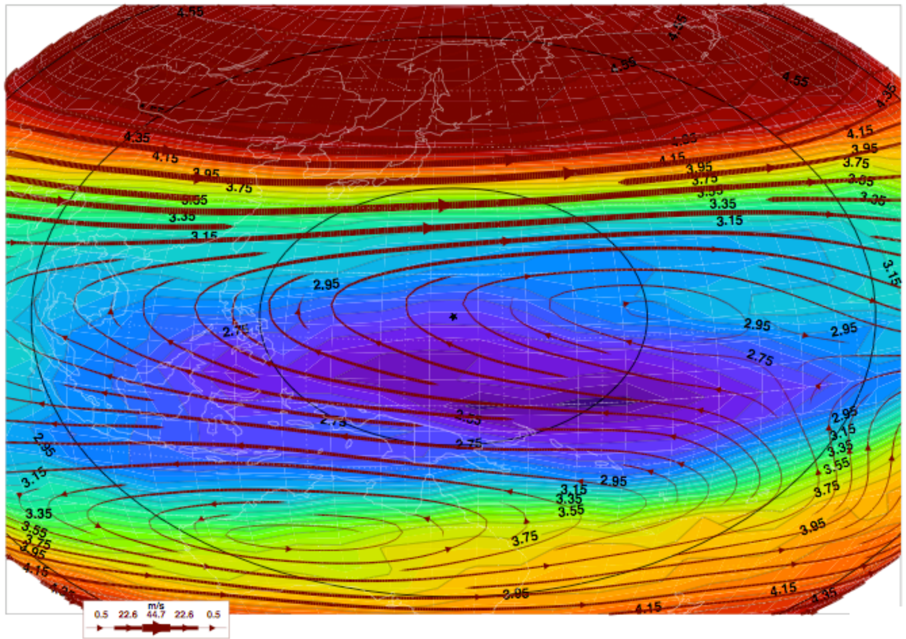


Left: Similarities in pattern for Calipso observed cirrus for winter and spring, but definitely lower incidence

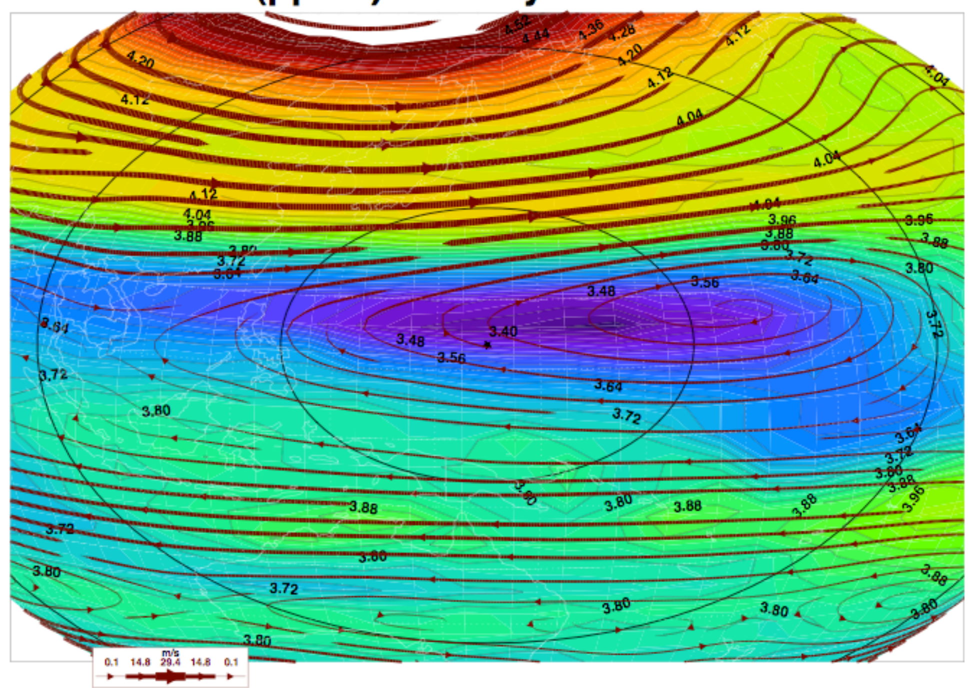
Below: Note much stronger ascent rates at 16 km during winter than during fall (previous deployment). Indian ocean region is clearly different in character, with descent at this altitude.

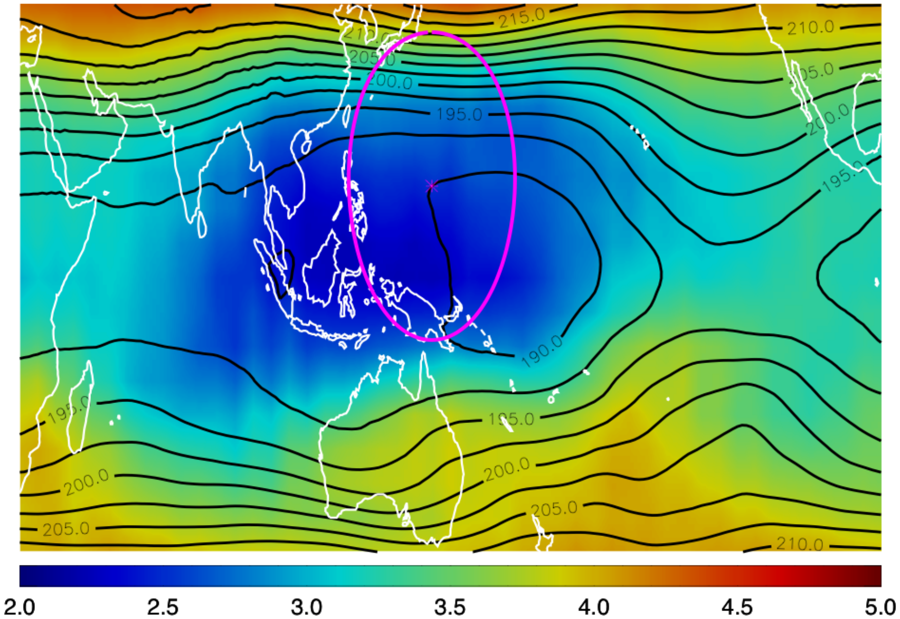


h2o mls (ppmv) January 2005-2009 100 hPa

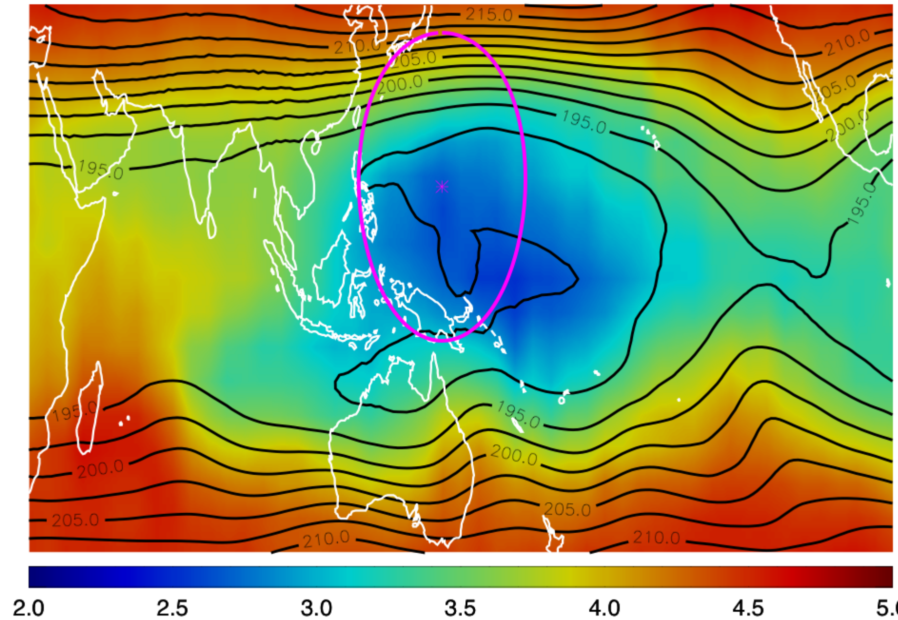


h2o mls (ppmv) January 2005-2009 68 hPa



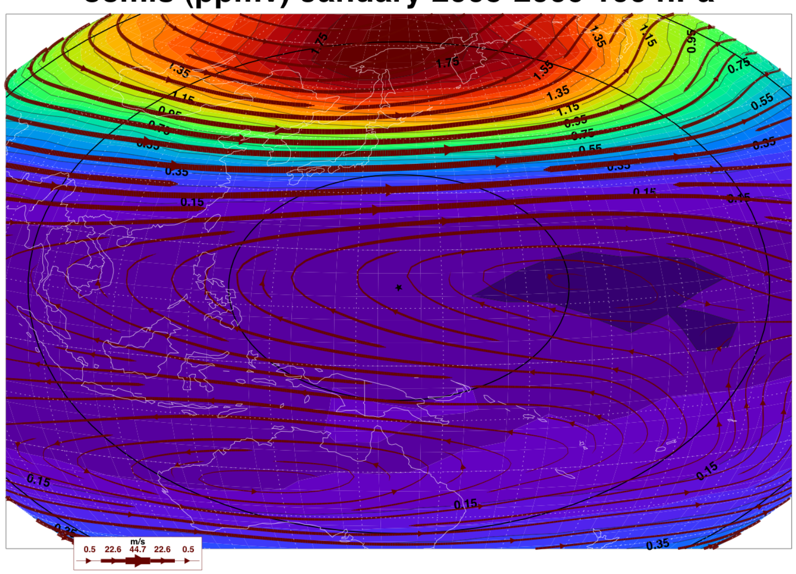


MLS Water Vapor in ppmv for January 1-31, 2006 at 16.2km mb



MLS Water Vapor in ppmv for January 1-31, 2007 at 16.2km mb

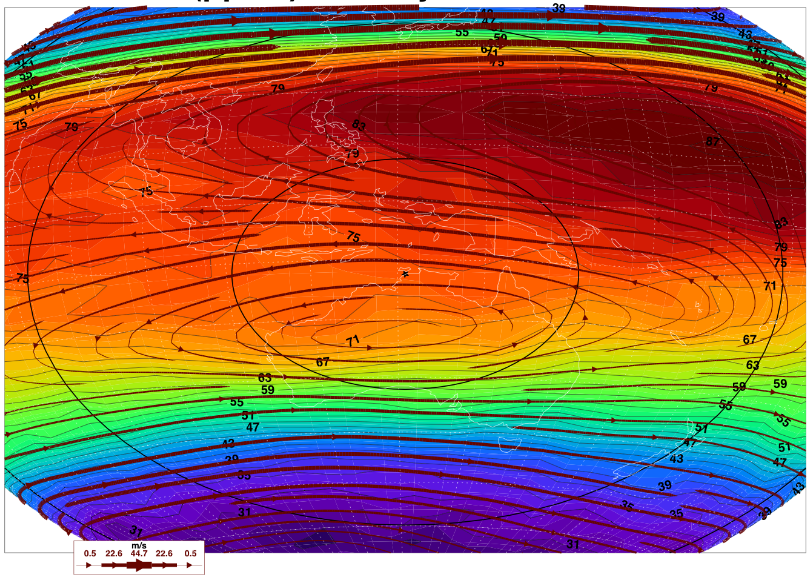
o3mls (ppmv) January 2005-2009 100 hPa



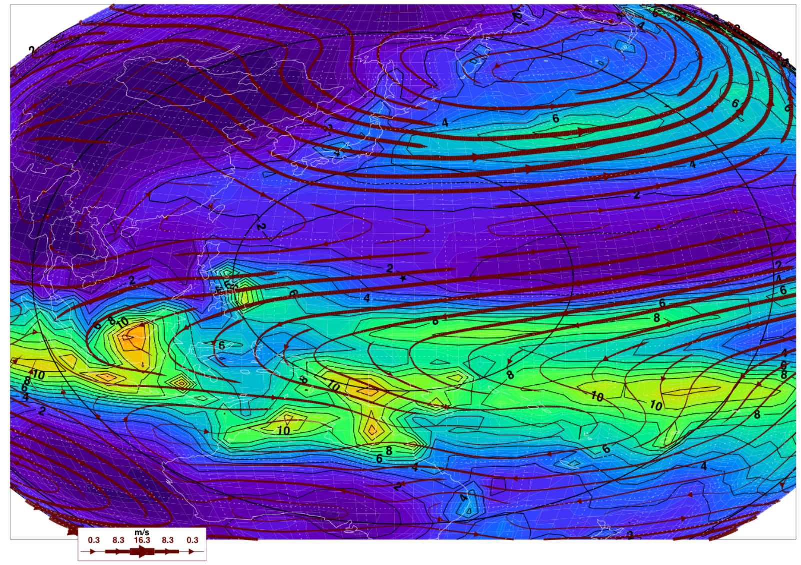
Year to year variability is demonstrated above in the January water for weak El Nino 2007 (ONI of .8) and neutral-La Nina year 2006 (ONI of -.6) QBO also a factor (about .5K). Cold temps displaced eastward during 2007 (also water).

Western Pac is in a region of strong stratospheric gradients, as ozone peak is displaced southward at these longitudes.

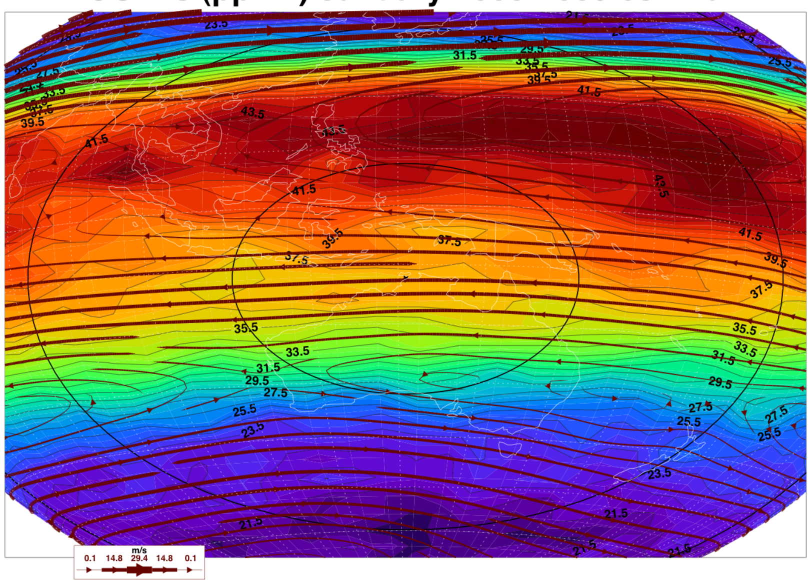
COmls (ppmv) January 2005-2009 100 hPa



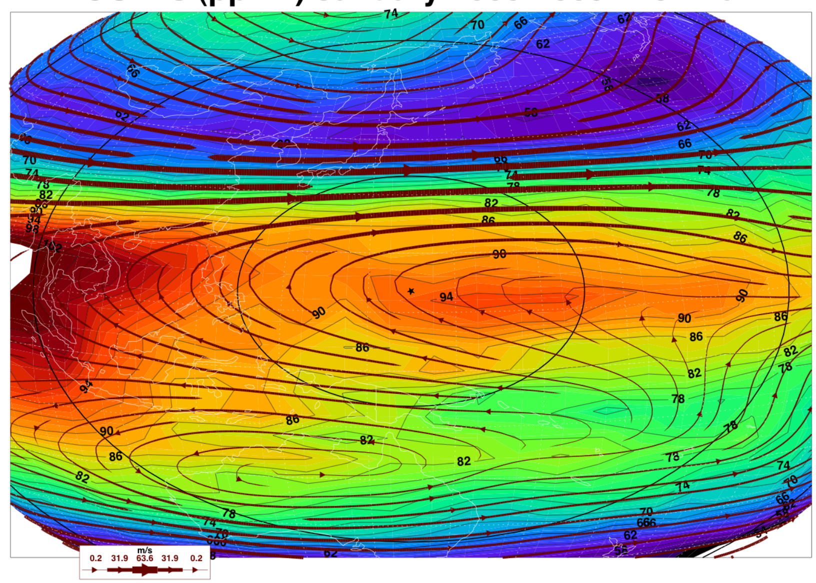
Rain (mm/day) January 1979-2008 850 hPa



COmls (ppmv) January 2005-2009 68 hPa



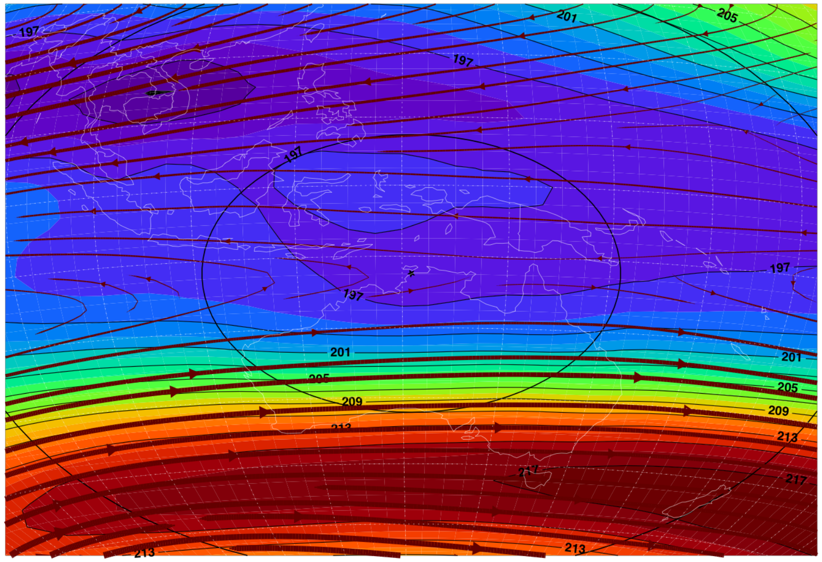
COmls (ppmv) January 2005-2009 146 hPa



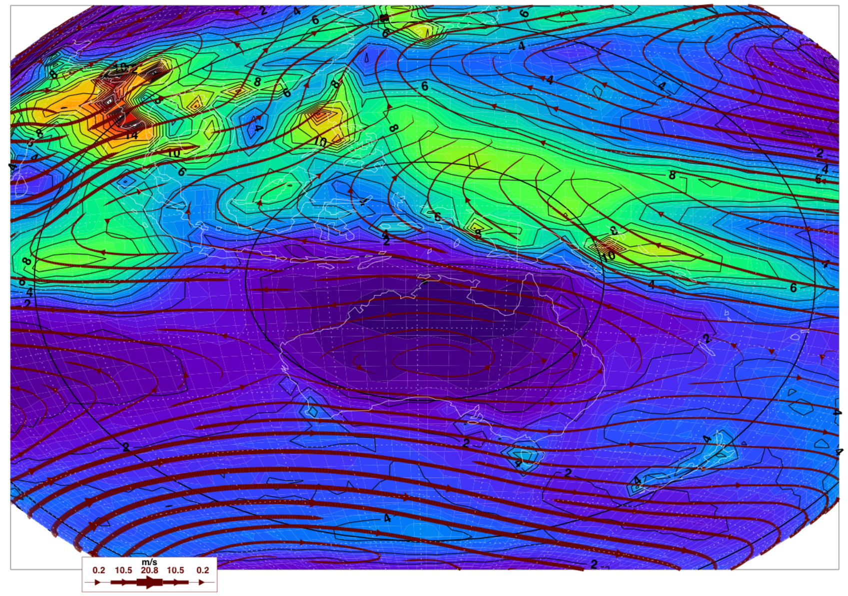
Summer Season

July, 2014 deployment

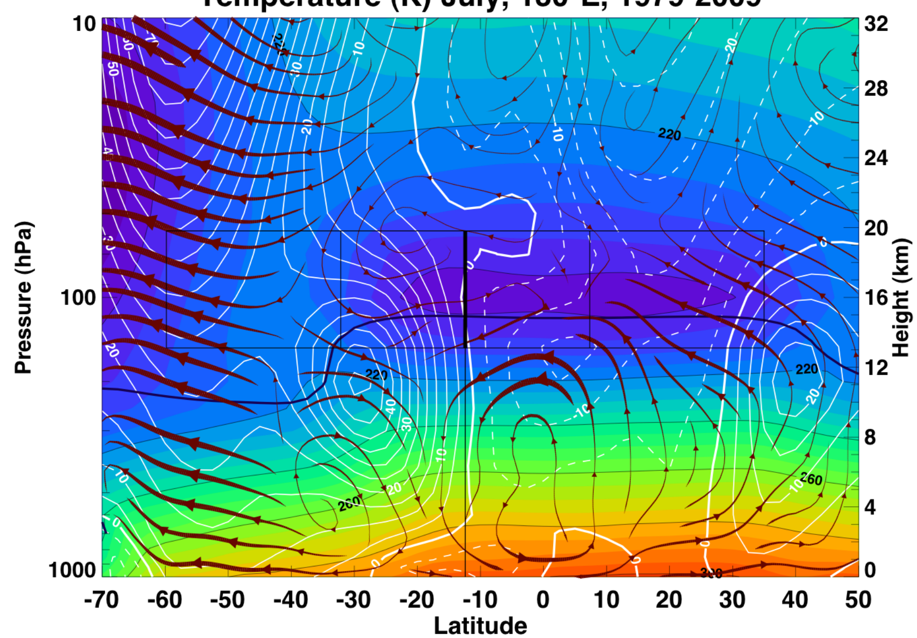
Temperature (K) July 1979-2007 100 hPa

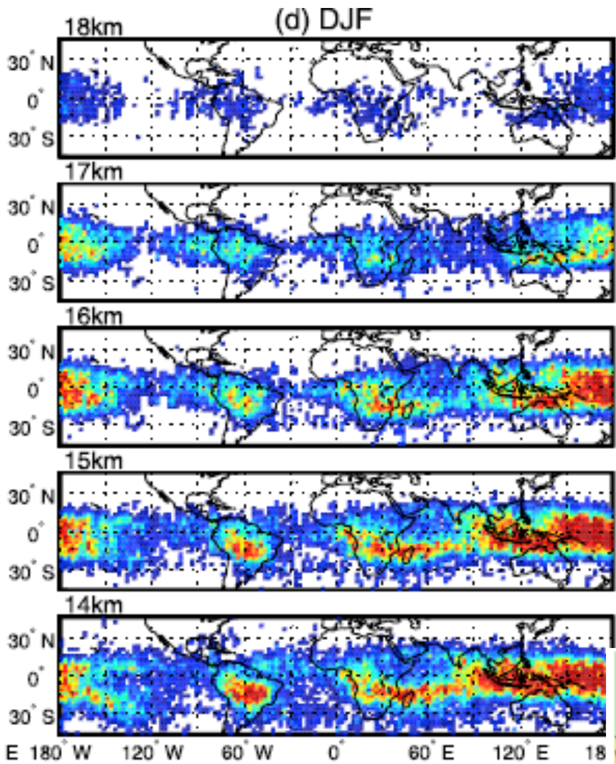


Rain (mm/day) July 1979-2008 850 hPa



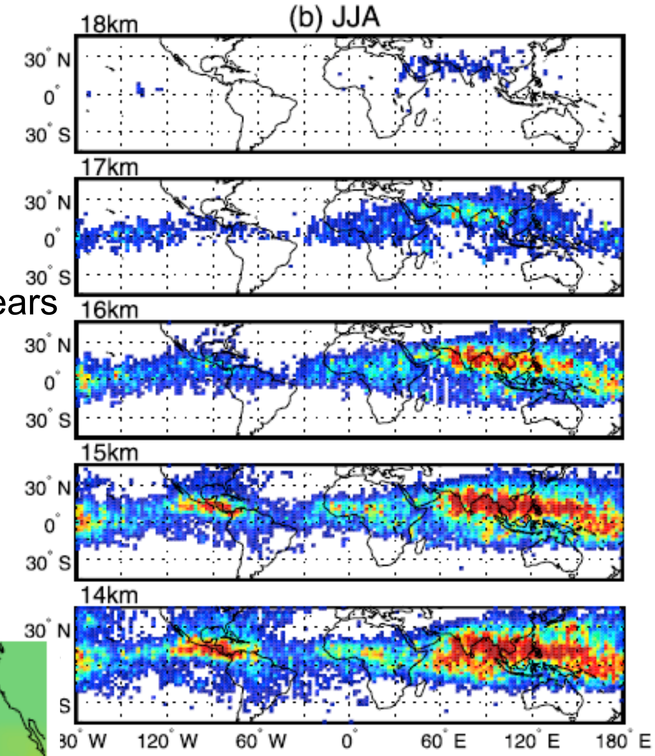
Temperature (K) July, 130^{o}E, 1979-2009

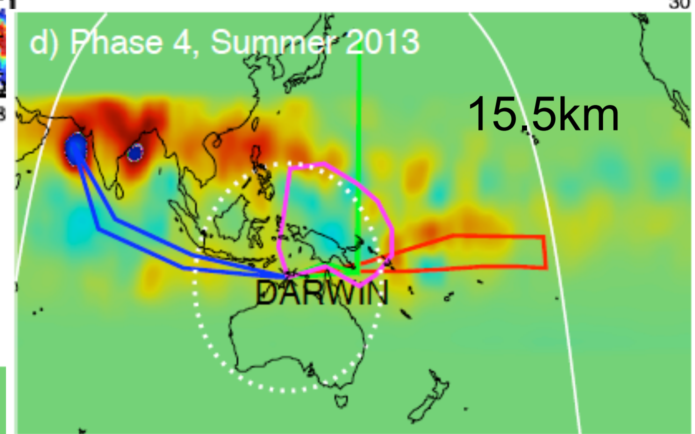


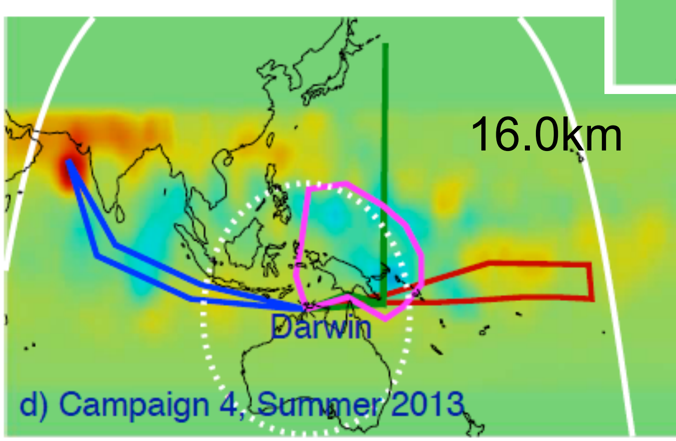


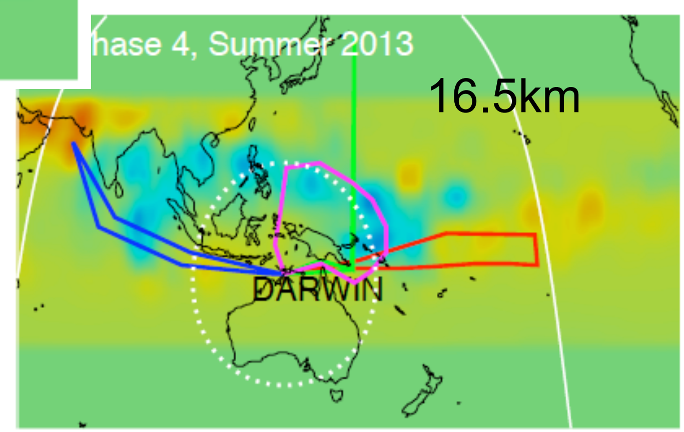
Cloud incidence at highest altitudes lower in summer, and over Asian monsoon anticyclone.

Upward motion into stratosphere appears mostly over Arabian sea.

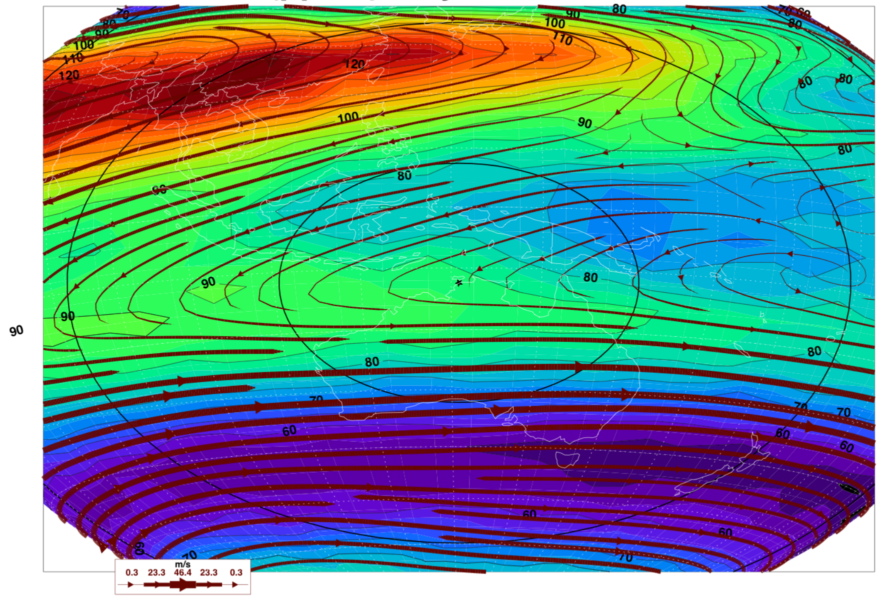




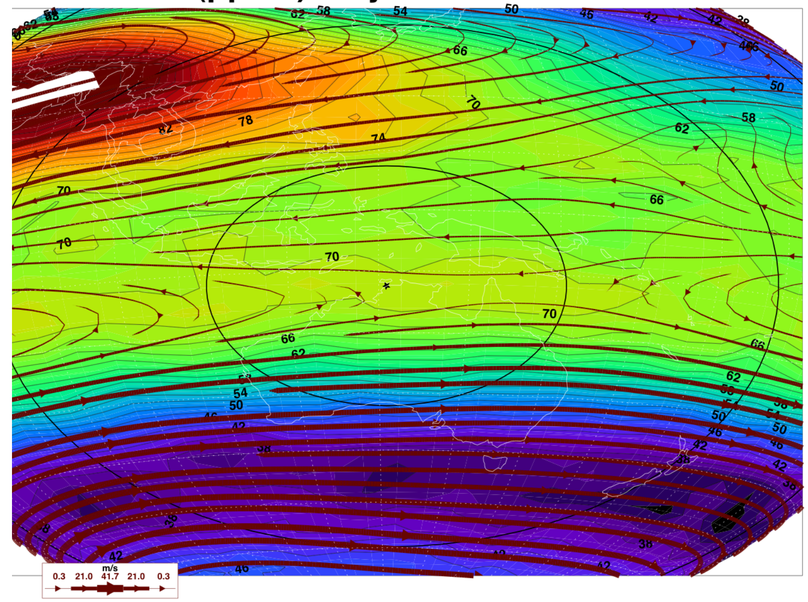




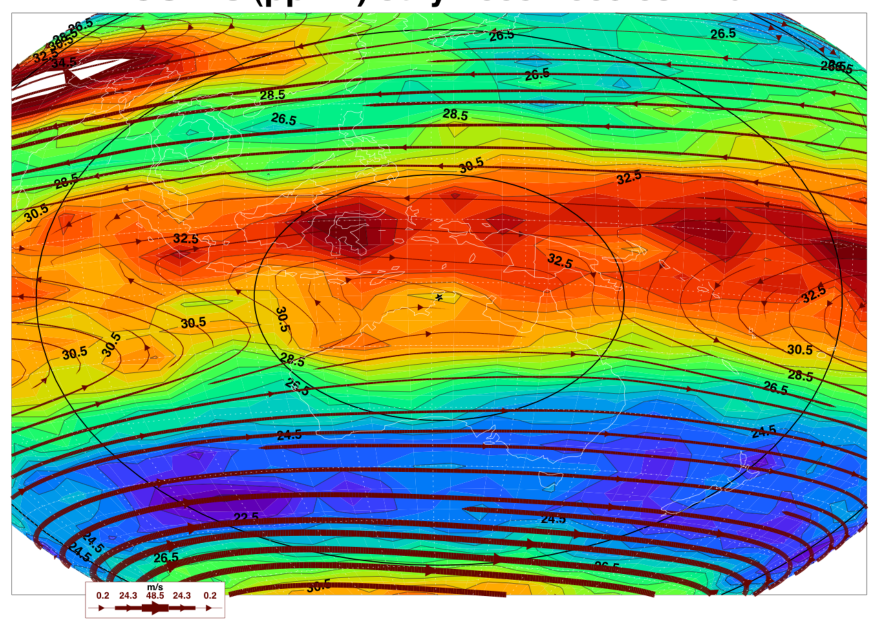
COmls (ppmv) July 2005-2009 146 hPa



COmls (ppmv) July 2005-2009 100 hPa



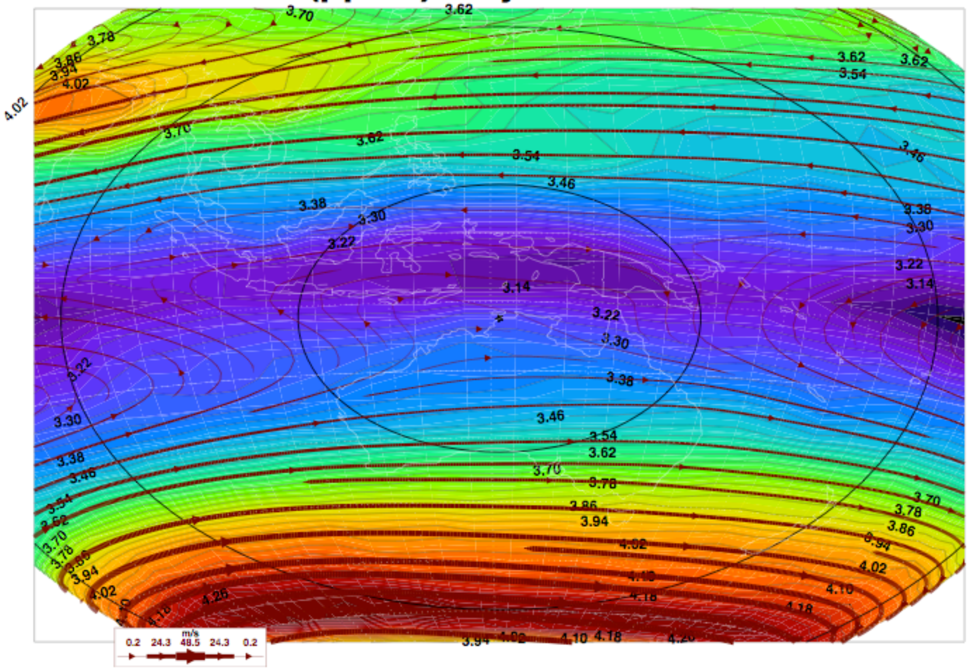
COmls (ppmv) July 2005-2009 68 hPa



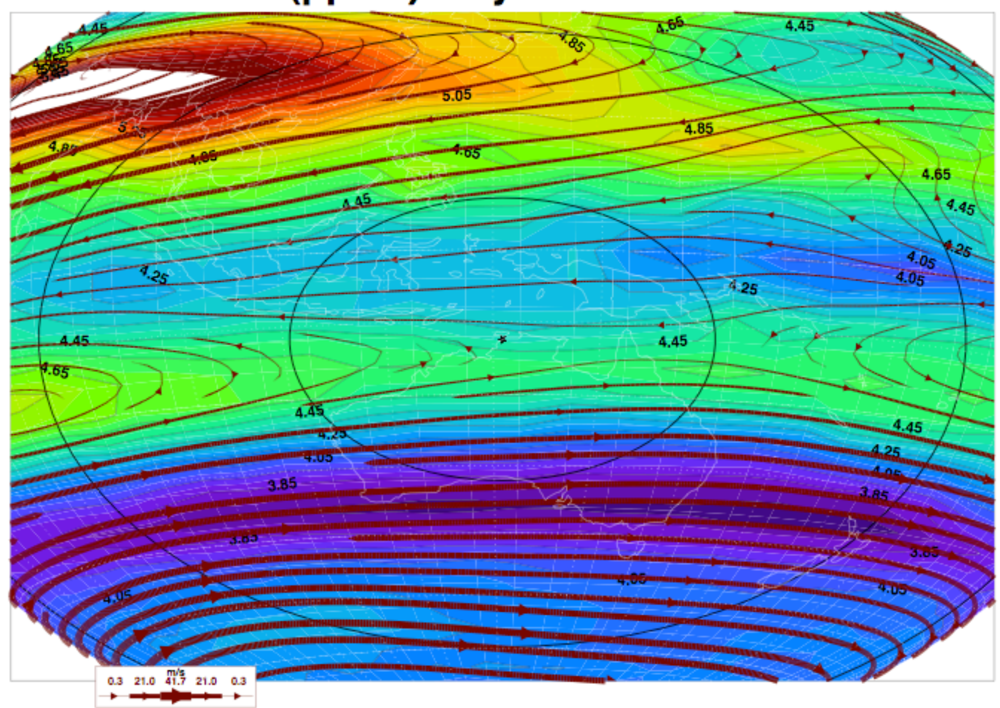
Asian monsoon anticyclone dominates the CO at all three altitudes. CO enhancement over equator at 70mb is not large (33 vs 26 ppbv)

Anticyclone penetrates further east at lower altitudes.

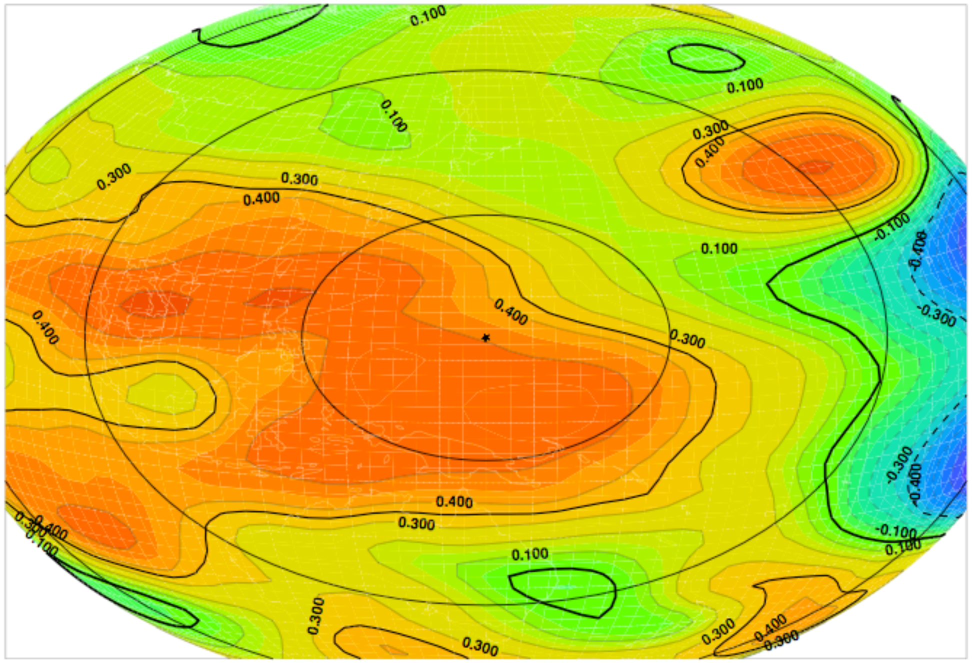
h2o mls (ppmv) July 2005-2009 68 hPa



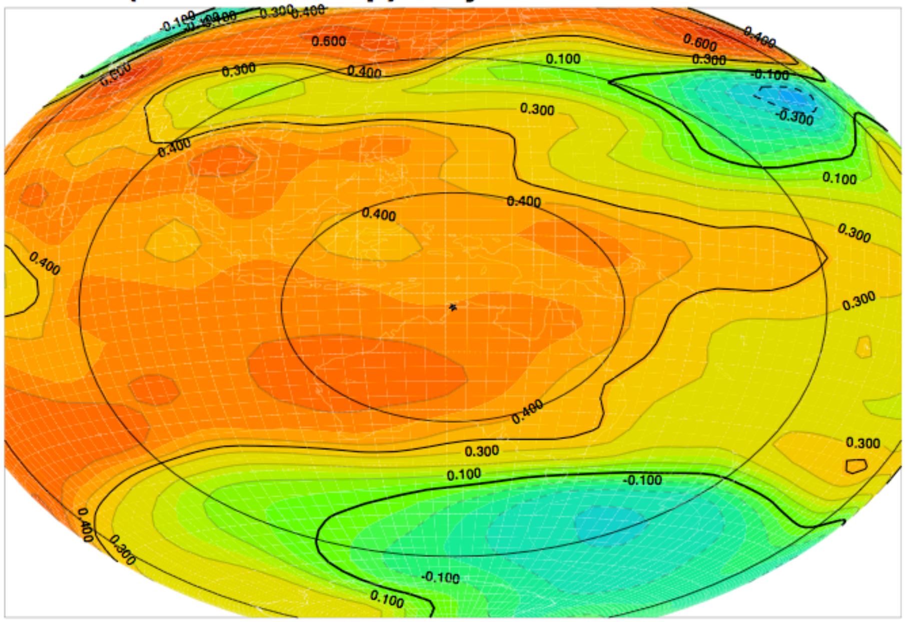
h2o mls (ppmv) July 2005-2009 100 hPa



R (ENSO w Temp) January 1979-2009 100 hPa



R (ENSO w Temp) July 1979-2009 100 hPa



ENSO effect on TTL temperatures

In tropics, where the coldest temps are found, winter clearly has the larger signal.

Highlights

- Fall (Dryden) is transition season, cirrus clouds a minimum south of Dryden, cold temperatures in West Pac are accessible. Vertical motion is relatively weak, convection is ITCZ (typically tops at 13 km. Typical tropical minimum average water vapor is about 4 ppmv.
- Boreal winter – well established anticyclone in western Pacific, with cold temperatures centered just to the south and west in TTL. Strong vertical motion, maximizes in western Pacific, maximum cirrus in western Pacific. Typical water vapor minima are (averaged) 2.5 ppmv.
- Boreal summer – monsoon anticyclone dominates the circulation, with temperature minimum to the south and east of the anticyclone center. Vertical motion is weak, with substantial upward motion within anticyclone. Anticyclone is wet and rich in CO, with drier air to the south
- ENSO effects on temperature strongest in winter.